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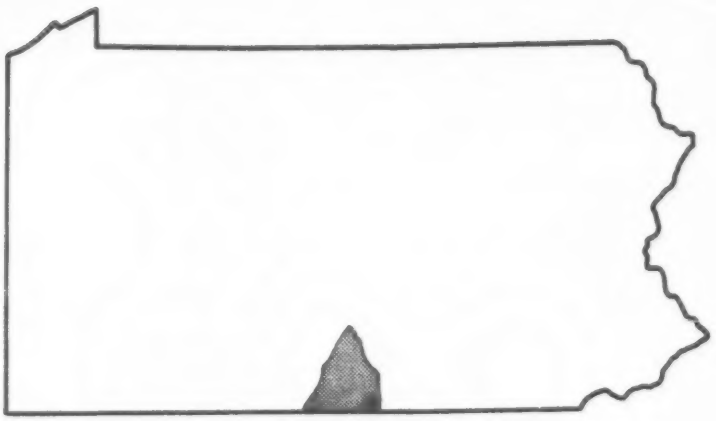
FLOOD INSURANCE STUDY

ORIGINAL

TOWNSHIP OF WASHINGTON, PENNSYLVANIA
FRANKLIN COUNTY



JUNE 3, 1986

Federal Emergency Management Agency

COMMUNITY NUMBER - 421658

TABLE OF CONTENTS

		Page
1.0	INTRODUCTION	1
	1.1 Purpose of Study	1
	1.2 Authority and Acknowledgements	1
	1.3 Coordination	1
2.0	AREA STUDIED	2
	2.1 Scope of Study	2
	2.2 Community Description	4
	2.3 Principal Flood Problems	5
	2.4 Flood Protection Measures	5
3.0	ENGINEERING METHODS	5
	3.1 Hydrologic Analyses	6
	3.2 Hydraulic Analyses	8
4.0	FLOOD PLAIN MANAGEMENT APPLICATIONS	9
	4.1 Flood Boundaries	9
	4.2 Floodways	9
5.0	INSURANCE APPLICATION	10
	5.1 Reach Determinations	15
	5.2 Flood Hazard Factors	18
	5.3 Flood Insurance Zones	18
	5.4 Flood Insurance Rate Map Description	19

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TABLE OF CONTENTS - continued

	Page
6.0 OTHER STUDIES	19
7.0 LOCATION OF DATA	19
8.0 BIBLIOGRAPHY AND REFERENCES	19

FIGURES

Figure 1 - Vicinity Map	3
Figure 2 - Floodway Schematic	15

TABLES

Table 1 - Summary of Discharges	7
Table 2 - Floodway Data	11 - 14
Table 3 - Flood Insurance Zone Data	16 - 17

EXHIBITS

Exhibit 1 - Flood Profiles

West Branch Antietam Creek	Panels 01P-03P - 22 - 24
East Branch Antietam Creek	Panels 04P-09P - 25 - 30
Red Run	Panels 10P-12P - 31 - 33
Falls Creek	Panels 13P-15P - 34 - 36

Exhibit 2 - Flood Boundary and Floodway Map Index
Flood Boundary and Floodway Map

PUBLISHED SEPARATELY:

Flood Insurance Rate Map Index
Flood Insurance Rate Map

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FLOOD INSURANCE STUDY
TOWNSHIP OF WASHINGTON, PENNSYLVANIA

1.0 INTRODUCTION

1.1 Purpose of Study

This Flood Insurance Study investigates the existence and severity of flood hazards in the Township of Washington, Franklin County, Pennsylvania, and aids in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. This study has developed flood risk data for various areas of the community that will be used to establish actuarial flood insurance rates and assist the community in their efforts to promote sound flood plain management. Minimum flood plain management requirements for participation in the National Flood Insurance Program are set forth in the Code of Federal Regulations at 44 CFR, 60.3.

In some states or communities, flood plain management criteria or regulations may exist that are more restrictive or comprehensive than the minimum Federal requirements. In such cases, the more restrictive criteria take precedence and the state (or other jurisdictional agency) will be able to explain them.

1.2 Authority and Acknowledgments

The sources of authority for this Flood Insurance Study are the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973.

The hydrologic and hydraulic analyses for this study were prepared by Michael Baker, Jr., Inc., for the Federal Emergency Management Agency (FEMA), under Contract No. EMW-83-1171. This work was completed in August 1984.

1.3 Coordination

A meeting between representatives of the township and the study contractor was held on September 7, 1983. During this meeting, existing reports, mapping, historic data, and photographs of past flood events were requested. On September 9, 1983, the study contractor met with representatives of Base Engineering to obtain data relative to release flow rates from Upper and Lower Royer Lake Dams, which are located at the headwaters of Falls Creek. No data regarding these non-flood control structures were given to the study contractor. Subsequent written correspondence also yielded no data for these streams.

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On October 5, 1983, the study contractor visited the Waynesboro Record-Herald newspaper for the purpose of obtaining written accounts of past flood events, as well as photographs. No photographs were available.

In April 1984, streams requiring detailed study were identified at an initial Consultation and Coordination Officer's (CCO) meeting attended by representatives of FEMA, the Township of Washington, and Michael Baker, Jr., Inc. (the study contractor).

Results of the hydrologic analyses were coordinated with the Baltimore District of the U. S. Army Corps of Engineers (COE), the Potomac River Basin Commission, the U. S. Geological Survey (USGS), and Greenhorne and O'Mara, Inc., Consulting Engineers.

On June 14, 1985, the results of the study were reviewed at a final CCO meeting attended by representatives of FEMA, the township, and the study contractor.

2.0 AREA STUDIED

2.1 Scope of Study

This Flood Insurance Study covers the incorporated area of the Township of Washington, Franklin County, Pennsylvania. The Borough of Waynesboro is not included in this study. The area of study is shown on the Vicinity Map (Figure 1).

The following streams were studied by detailed methods: West Branch Antietam Creek from a point approximately 0.34 mile downstream of Marsh Road to the upstream corporate limits; East Branch Antietam Creek from the Goods Dam Road bridge to the confluence of Deer Lick Creek; Red Run from its confluence with East Branch Antietam Creek to the Skiway Drive bridge; and Falls Creek from its confluence with Red Run to the private drive bridge at the base of Mount Dunlop. The areas studied by detailed methods were selected with priority given to all known flood hazard areas and areas of projected development and proposed construction through August 1989.

Antietam Creek, Marsh Run, Biesecker Run, an unnamed tributary to West Branch Antietam Creek, an unnamed tributary to East Branch Antietam Creek, and the remaining portions of West Branch Antietam Creek and East Branch Antietam Creek were studied by approximate methods. Approximate analyses were used to study those areas having a low development potential or minimal flood hazards. The scope and methods of study were proposed to, and agreed upon by, FEMA and the Township of Washington.

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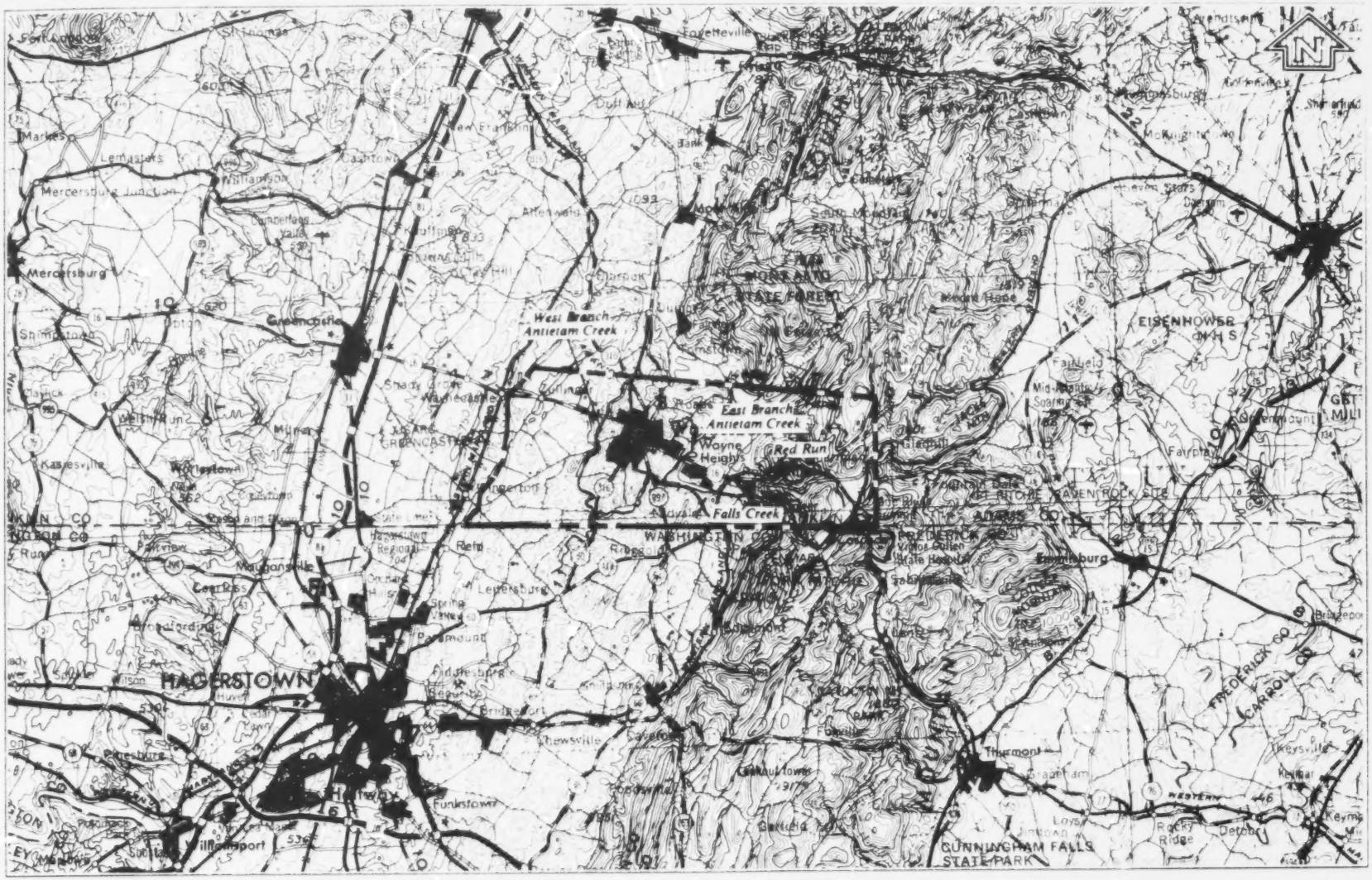

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWNSHIP OF WASHINGTON, PA

(FRANKLIN CO.)

APPROXIMATE SCALE

4 0 4 8 12 MILES

VICINITY MAP

FIGURE 1

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2.2 Community Description

The Township of Washington is located in the southeastern portion of Franklin County in south-central Pennsylvania, approximately 19 miles southwest of Gettysburg, Pennsylvania, and 11 miles northeast of Hagerstown, Maryland. It is bordered by the Township of Antrim to the west, the Township of Quincy to the north, the Township of Hamiltonban to the northeast, the Township of Liberty to the southeast, and Washington County, Maryland, to the south. The total land area contained within Washington is 38.2 square miles. According to the U. S. Bureau of the Census, the population of Washington increased from 8,514 in 1970 to 9,616 in 1980 (Reference 1).

West Branch Antietam Creek flows south through the township to its confluence with East Branch Antietam Creek to form Antietam Creek. It is 12.6 miles long, with a drainage area of 41.4 square miles. East Branch Antietam Creek also flows south through Washington. It is 13.8 miles long and has a drainage area of 51.9 square miles.

Red Run, a tributary to East Branch Antietam Creek, flows east 6.6 miles. It has a total drainage area of 16.3 square miles. Falls Creek is a tributary of Red Run and is 4 miles long. The drainage area of Falls Creek is 5.1 square miles.

The majority of Washington is situated in the Appalachian Valley and Ridge Physiographic Province of Pennsylvania and is characterized in its western section by gently rolling terrain. The Cumberland Valley is underlain by calcareous deposits of Cambrian and Ordovician Age, which have been eroded more rapidly than the siliceous formations that form the surrounding mountains. The soil in this area is of average permeability and supports a wide variety of vegetation within the drainage area.

The eastern section of the township is located in the Blue Ridge Physiographic Province of Pennsylvania. In this area, the province is dominated by South Mountain and the foothills surrounding it. South Mountain, which is a part of the Appalachian Mountains, rises to elevations of approximately 2,200 feet (Reference 2). The range in local elevation in the township varies from 540 to 1,840 feet.

Most of Washington consists of either agricultural or residential development. Commercial development is located primarily along State Route 16, and the eastern section of the township is characterized by undeveloped forest lands. Flood plains within the township are primarily used for recreational and agricultural purposes. Major transportation arteries serving Washington include State Routes 16, 316, and 997 as well as Conrail, which provides rail service to the area.

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The climate of Washington is humid continental. Summer and winter temperatures average 74.9 degrees Fahrenheit (°F) and 31.6°F, respectively. The average annual precipitation of the region is 41.3 inches, while recorded snowfall totals 36.6 inches (Reference 3).

2.3 Principal Flood Problems

The recreational and agricultural land use of the flood plains in Washington has served to minimize the effects of overbank flooding resulting from major storms. While the potential for development in the flood plains exists, actual residential development in this area is sufficiently removed so as to contain structural flooding to basements and uninhabited out buildings.

No damage estimates were available for the township, however, conversations with local officials and residents indicated that damage to agricultural crops and bridges was common. In addition, it was noted that channel bank erosion was prevalent throughout the township.

2.4 Flood Protection Measures

There are no flood protection structures within the township. As previously mentioned, erosion of the stream banks is a problem throughout the area. Several portions of streams have been treated by riprapping and gabions to contain this erosion. These measures, however, do not act as flood mitigation devices.

Through the use of a sound flood plain management and building permit procedure, the township has succeeded in minimizing construction in the flood plains and mitigating the effects of flooding.

There are two small dams located on the headwaters of Falls Creek at the U. S. Army installation at Fort Ritchie, Maryland. These dams were not designed as flood control structures but as impoundments for the making of ice. Attempts were made to obtain release rate data for these dams; however, these attempts were unsuccessful. Discussions with Army engineering personnel indicated that their studies have shown a total dam failure would have no significant effect in the study area. Therefore, the effects of these dams were considered negligible for this study.

3.0 ENGINEERING METHODS

For the flooding sources studied in detail in the community, standard hydrologic and hydraulic study methods were used to determine the flood hazard data required for this study. Flood events of a magnitude which are expected to be equaled or exceeded once on the average during any 10-, 50-, 100-, or

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500-year period (recurrence interval) have been selected as having special significance for flood plain management and for flood insurance rates. These events, commonly termed the 10-, 50-, 100-, and 500-year floods, have a 10, 2, 1, and 0.2 percent chance, respectively, of being equaled or exceeded during any year. Although the recurrence interval represents the long term average period between floods of a specific magnitude, rare floods could occur at short intervals or even within the same year. The risk of experiencing a rare flood increases when periods greater than 1 year are considered. For example, the risk of having a flood which equals or exceeds the 100-year flood (1 percent chance of annual exceedence) in any 50-year period is approximately 40 percent (4 in 10), and, for any 90-year period, the risk increases to approximately 60 percent (6 in 10). The analyses reported herein reflect flooding potentials based on conditions existing in the community at the time of completion of this study. Maps and flood elevations will be amended periodically to reflect future changes.

3.1 Hydrologic Analyses

Hydrologic analyses were carried out to establish the peak discharge-frequency relationships for each flooding source studied in detail affecting the community.

For the detailed study of West Branch Antietam Creek, East Branch Antietam Creek, Red Run, and Falls Creek, the hydrologic analysis was performed using available discharge-frequency data to avoid duplication of effort. The basic discharge-frequency, drainage area relationships were obtained from the Flood Insurance Study for Washington County, Maryland (Reference 4). This information was supplemented with log-Pearson Type III distribution frequency analyses by the USGS of the Antietam Creek gage (No. 016900) located near Waynesboro.

Drainage area versus discharge was plotted on log-log paper and a least-squares fit was performed for each of the recurrence intervals under investigation. The correlation coefficients of the resultant equations, relating discharge to drainage area, were favorable, indicating that discharges derived from these equations would be consistent with data on similar streams in the Flood Insurance Study for Washington County, Maryland (Reference 4). Discharges obtained from the equations developed were within the 90 percent confidence limits of the USGS-computed discharges for the Waynesboro gage on Antietam Creek. The equations were used to develop peak discharges at various points along the streams in the township.

A comparison of proposed discharges with those derived from other methods was made. Discharges were computed using methods described in the USGS Water Resources Investigation 82-21 (Reference 5). This publication supercedes Water Resources Bulletin No. 13 for determining flood flow

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discharges in Pennsylvania and yielded answers consistent with those developed from the equations. The proposed discharges were within the standard error of those obtained from Water Resources Investigation 82-21. Discharges were also computed using PSU-IV (Reference 6). However, they were considerably higher than those derived by the other methods and inconsistent with the USGS gage analysis. The PSU-IV method was, therefore, considered inappropriate for use as a comparative method.

A summary of drainage area-peak discharge relationships for the streams studied by detailed methods is shown in Table 1, "Summary of Discharges."

TABLE 1 - SUMMARY OF DISCHARGES

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs) 10-YEAR	50-YEAR	100-YEAR	500-YEAR
WEST BRANCH ANTIETAM CREEK					
At Marsh Road	37.7	1,470	2,620	3,480	6,010
At State Route 16 (Main Street)	34.5	1,370	2,430	3,240	5,630
At the upstream corporate limits	17.7	780	1,360	1,870	3,450
EAST BRANCH ANTIETAM CREEK					
At Goods Dam Road	47.6	1,790	3,200	4,220	7,130
At Welty Road	30.6	1,240	2,190	2,940	5,170
At State Route 16	29.5	1,200	2,120	2,850	5,020
Upstream of the confluence of Biesecker Run	21.8	930	1,630	2,220	4,020
At the confluence of Deer Lick Run	18.4	810	1,420	1,930	3,560
RED RUN					
At its confluence with East Branch Antietam Creek	16.3	730	1,270	1,750	3,250
At private bridge	15.4	700	1,220	1,670	3,120
At the confluence of Falls Creek	10.6	510	880	1,230	2,380
At State Route 16 (Buchanan Trail East)	5.2	280	480	680	1,410
At Skiway Drive	4.4	240	420	600	1,250
FALLS CREEK					
At its confluence with Red Run	5.1	270	470	670	1,390

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Discharges for the streams studied by approximate methods were based on the flood-frequency analysis described in USGS Water-Supply Paper 1672 (Reference 7). These discharges were used in conjunction with USGS topographic maps to determine that approximate flood boundaries from the Flood Hazard Boundary Map for Washington were still valid (References 8 and 9). Some adjustments were made to match detailed mapping.

3.2 Hydraulic Analyses

Analyses of the hydraulic characteristics of flooding from the sources studied were carried out to provide estimates of the elevations of floods of the selected recurrence intervals.

Cross sections for the backwater analyses of the streams studied in detail were obtained from aerial photographs flown in December 1983 (Reference 10). Below-water sections were obtained by field measurement. All bridges, dams, and culverts were field surveyed to obtain elevation data and structural geometry.

Locations of selected cross sections used in the hydraulic analyses are shown on the Flood Profiles (Exhibit 1). For stream segments for which a floodway was computed (Section 4.2), selected cross section locations are also shown on the Flood Boundary and Floodway Map (Exhibit 2).

Water-surface elevations of floods of the selected recurrence intervals were computed using the COE HEC-2 step-backwater computer program (Reference 11). Flood profiles were drawn showing computed water-surface elevations for floods of the selected recurrence intervals. Starting water-surface elevations for West Branch Antietam Creek, East Branch Antietam Creek, and Falls Creek were calculated by the slope/area method. Starting water-surface elevations for Red Run were determined assuming coincident flood peaks with East Branch Antietam Creek.

Roughness factors (Manning's "n") used in the hydraulic computations were chosen by engineering judgment and based on field observations of the streams and flood plain areas. The channel "n" and overbank "n" values for the streams studied by detailed methods are shown in the following tabulation:

Stream	Channel "n"	Overbank "n"
West Branch Antietam Creek	0.035-0.060	0.040-0.090
East Branch Antietam Creek	0.035-0.050	0.040-0.120
Red Run	0.017-0.045	0.050-0.090
Falls Creek	0.045	0.050-0.090

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All elevations are referenced to the National Geodetic Vertical Datum of 1929 (NGVD). Elevation reference marks used in this study are shown on the maps.

The hydraulic analyses for this study were based on unobstructed flow. The flood elevations shown on the profiles are thus considered valid only if hydraulic structures remain unobstructed, operate properly, and do not fail.

4.0 FLOOD PLAIN MANAGEMENT APPLICATIONS

The National Flood Insurance Program encourages State and local governments to adopt sound flood plain management programs. Therefore, each Flood Insurance Study produces maps designed to assist communities in developing flood plain management measures.

4.1 Flood Boundaries

To provide a national standard without regional discrimination, the 1 percent annual chance (100-year) flood has been adopted by FEMA as the base flood for flood plain management purposes. The 0.2 percent annual chance (500-year) flood is employed to indicate additional areas of flood risk in the community. For each stream studied in detail, the 100- and 500-year flood plain boundaries have been delineated using the flood elevations determined at each cross section. Between cross sections, the boundaries were interpolated using topographic maps (Reference 12).

For the streams studied by approximate methods, the boundary of the 100-year flood was delineated using USGS topographic maps and the Flood Hazard Boundary Map for the Township of Washington (References 8 and 9).

The 100- and 500-year flood plain boundaries are shown on the Flood Boundary and Floodway Map (Exhibit 2). In cases where the 100- and 500-year flood plain boundaries are close together, only the 100-year flood plain boundary has been shown. Small areas within the flood plain boundaries may lie above the flood elevations but cannot be shown due to limitations of the map scale and/or lack of detailed topographic data.

4.2 Floodways

Encroachment on flood plains, such as structures and fill, reduces flood-carrying capacity, increases flood heights and velocities, and increases flood hazards in areas beyond the encroachment itself. One aspect of flood plain management involves balancing the economic gain from flood plain development against the resulting increase in flood hazard. For purposes of the National Flood Insurance Program, a floodway is used as a

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tool to assist local communities in this aspect of flood plain management. Under this concept, the area of the 100-year flood plain is divided into a floodway and a floodway fringe. The floodway is the channel of a stream, plus any adjacent flood plain areas, that must be kept free of encroachment so that the 100-year flood can be carried without substantial increases in flood heights. Minimum federal standards limit such increases to 1.0 foot, provided that hazardous velocities are not produced. The floodways in this study are presented to local agencies as minimum standards that can be adopted directly or that can be used as a basis for additional floodway studies.

From the downstream face of Penmar/Airport Road to the upstream limit of detailed study, the 100-year flood on Falls Creek was found to be confined to the channel and, therefore, a floodway was not computed through this area.

The floodways presented in this study were computed on the basis of equal conveyance reduction from each side of the flood plain. The results of these computations are tabulated at selected cross sections for each stream segment for which a floodway is computed (Table 2).

As shown on the Flood Boundary and Floodway Map (Exhibit 2), the floodway boundaries were computed at cross sections. Between cross sections, the boundaries were interpolated. In cases where the floodway and 100-year flood plain boundaries are either close together or collinear, only the floodway boundary has been shown. Portions of the floodway widths for West Branch Antietam Creek and Red Run extend beyond the corporate limits.

The area between the floodway and 100-year flood plain boundaries is termed the floodway fringe. The floodway fringe encompasses the portion of the flood plain that could be completely obstructed without increasing the water-surface elevation of the 100-year flood by more than 1.0 foot at any point. Typical relationships between the floodway and the floodway fringe and their significance to flood plain development are shown in Figure 2.

5.0 INSURANCE APPLICATION

To establish actuarial insurance rates, data from the engineering study must be transformed into flood insurance criteria. This process includes the determination of reaches, Flood Hazard Factors, and flood insurance zone designations for each flooding source studied in detail in the Township of Washington.

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FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
					(FEET NGVD)			
West Branch Antietam Creek								
A	15,750	226	464	7.5	590.8	590.8	591.7	0.9
B	16,400	179	755	4.6	596.0	596.0	596.6	0.6
C	17,200	88	431	8.1	597.1	597.1	597.9	0.8
D	17,900	168/154[2]	1,134	3.1	600.3	600.3	601.3	1.0
E	20,800	255/20[2]	1,247	2.8	605.7	605.7	606.5	0.8
F	21,250	110/75[2]	490	6.6	607.8	607.8	608.0	0.2
G	22,400	233/140[2]	693	4.7	610.3	610.3	611.0	0.7
H	23,300	193/50[2]	850	3.8	612.3	612.3	613.1	0.8
I	24,100	162	656	4.9	613.7	613.7	614.4	0.7
J	24,400	270	1,237	2.6	616.2	616.2	617.0	0.8
K	26,100	107	456	7.1	619.2	619.2	619.8	0.6
L	26,600	181	341	3.9	621.2	621.2	622.1	0.9
M	28,300	364	796	2.4	624.8	624.8	625.7	0.9
N	29,100	255	1,196	1.6	631.7	631.7	631.7	0.0
O	29,900	143	299	6.4	631.7	631.7	631.7	0.0
P	30,400	30	285	6.7	639.8	639.8	639.8	0.0
Q	31,800	183	881	2.2	642.2	642.2	642.5	0.3

[1]Feet above confluence with Antietam Creek

[2]Width/width within corporate limits

TABLE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWNSHIP OF WASHINGTON, PA

(FRANKLIN CO.)

FLOODWAY DATA

WEST BRANCH ANTIETAM CREEK

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FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
					(FEET NGVD)			
East Branch Antietam Creek								
A	8,600	274	1,097	3.8	577.0	577.0	578.0	1.0
B	9,250	277	756	5.6	578.8	578.8	579.7	0.9
C	10,200	343	1,510	2.8	581.2	581.2	582.1	0.9
D	11,700	114	638	6.6	583.0	583.0	583.9	0.9
E	13,400	174	1,100	3.8	587.4	587.4	588.4	1.0
F	14,200	200	1,104	3.8	588.8	588.8	589.7	0.9
G	15,000	434	1,707	2.5	590.2	590.2	591.2	1.0
H	15,500	266	1,515	2.8	593.4	593.4	593.4	0.0
I	16,700	281	935	4.5	594.4	594.4	594.9	0.5
J	17,600	264	1,133	3.7	598.7	598.7	599.7	1.0
K	19,250	75	286	10.3	603.0	603.0	603.0	0.0
L	20,500	502	1,526	1.9	608.4	608.4	609.2	0.8
M	21,750	91	303	9.7	613.0	613.0	613.6	0.6
N	22,650	404	974	2.9	618.9	618.9	619.4	0.5
O	23,000	199	1,073	2.7	621.6	621.6	621.7	0.1
P	24,700	505	1,259	2.3	624.5	624.5	625.5	1.0
Q	25,800	166	387	7.4	628.8	628.8	629.0	0.2
R	27,300	174	728	3.7	636.1	636.1	637.1	1.0
S	28,200	237	487	5.5	641.0	641.0	641.4	0.4
T	29,550	393	1,216	2.2	646.0	646.0	646.9	0.9
U	31,100	133	403	6.7	650.5	650.5	650.9	0.4
V	32,400	191	604	4.4	659.0	659.0	659.3	0.3
W	33,700	115	695	3.9	670.9	670.9	671.4	0.5

[1]Feet above confluence Antietam Creek

TABLE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWNSHIP OF WASHINGTON, PA

(FRANKLIN CO.)

FLOODWAY DATA

EAST BRANCH ANTIETAM CREEK

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FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY (FEET NGVD)	WITH FLOODWAY	INCREASE
Red Run (continued)								
I	5,800[1]	70	198	8.4	634.9	634.9	634.9	0.0
J	6,600[1]	72	193	8.7	641.3	641.3	641.3	0.0
K	7,250[1]	219	543	3.1	645.7	645.7	646.5	0.8
L	8,000[1]	168	338	4.9	650.7	650.7	650.9	0.2
M	9,900[1]	45	127	9.7	670.8	670.8	670.8	0.0
N	10,900[1]	90	224	5.5	682.8	682.8	682.9	0.1
O	11,700[1]	90	149	8.3	692.3	692.3	692.3	0.0
P	12,200[1]	16	70	9.7	695.9	695.9	695.9	0.0
Q	13,500[1]	25	71	9.6	714.1	714.1	715.1	1.0
R	14,800[1]	33	77	8.8	731.4	731.4	731.9	0.5
S	15,600[1]	27	100	6.8	743.9	743.9	743.9	1.0
T	16,820[1]	33	78	8.7	765.0	765.0	765.0	0.0
U	17,200[1]	20	65	10.4	775.5	775.5	775.5	0.0
Falls Creek								
A	650[2]	36	100	6.7	658.8	658.8	659.1	0.3
B	1,450[2]	32	92	7.3	667.6	667.6	667.6	0.0
C	2,300[2]	50	135	5.0	679.3	679.3	679.7	0.4
D	3,700[2]	97	138	4.8	700.1	700.1	700.5	0.4
E	4,500[2]	78	130	5.2	713.8	713.8	714.6	0.8
F	5,500[2]	61	110	6.1	733.4	733.4	734.4	1.0

[1]Feet above confluence with East Branch Antietam Creek

[2]Feet above confluence with Red Run

TABLE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWNSHIP OF WASHINGTON, PA

(FRANKLIN CO.)

FLOODWAY DATA

RED RUN - FALLS CREEK

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FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
					(FEET NGVD)			
East Branch Antietam Creek (continued)								
X	34,300[1]	194	559	4.0	671.5	671.5	672.0	0.5
Y	35,100[1]	495	452	4.9	676.7	676.7	676.8	0.1
Z	36,050[1]	937	1,379	1.6	684.8	684.8	684.9	0.1
AA	36,600[1]	110	333	6.7	687.8	687.8	687.8	0.0
AB	36,800[1]	95	835	2.7	689.3	689.3	689.3	0.0
AC	39,000[1]	375	694	3.2	709.3	709.3	709.7	0.4
AD	40,600[1]	330	488	4.5	721.6	721.6	721.6	0.0
AE	42,350[1]	215	432	5.1	735.4	735.4	735.8	0.4
AF	43,850[1]	210	367	6.0	748.6	748.6	748.8	0.2
AG	44,700[1]	200	552	3.5	753.3	753.3	754.2	0.9
Red Run								
A	500[2]	68/33[3]	211	8.3	600.4	600.4	600.4	0.0
B	1,200[2]	153	352	5.0	603.9	603.9	604.8	0.9
C	1,500[2]	143	433	4.0	605.4	605.4	606.2	0.8
D	1,800[2]	234	921	1.9	608.5	608.5	608.7	0.2
E	2,400[2]	63	181	9.7	609.7	609.7	609.7	0.0
F	3,700[2]	249	457	3.8	620.2	620.2	620.6	0.4
G	4,200[2]	85	224	7.8	623.5	623.5	623.6	0.1
H	4,600[2]	79	328	5.3	625.9	625.9	626.9	1.0

[1]Feet above confluence with Antietam Creek

[2]Feet above confluence with East Branch Antietam Creek

[3]Width/width within corporate limits

TABLE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWNSHIP OF WASHINGTON, PA

(FRANKLIN CO.)

FLOODWAY DATA

EAST BRANCH ANTIETAM CREEK -RED RUN

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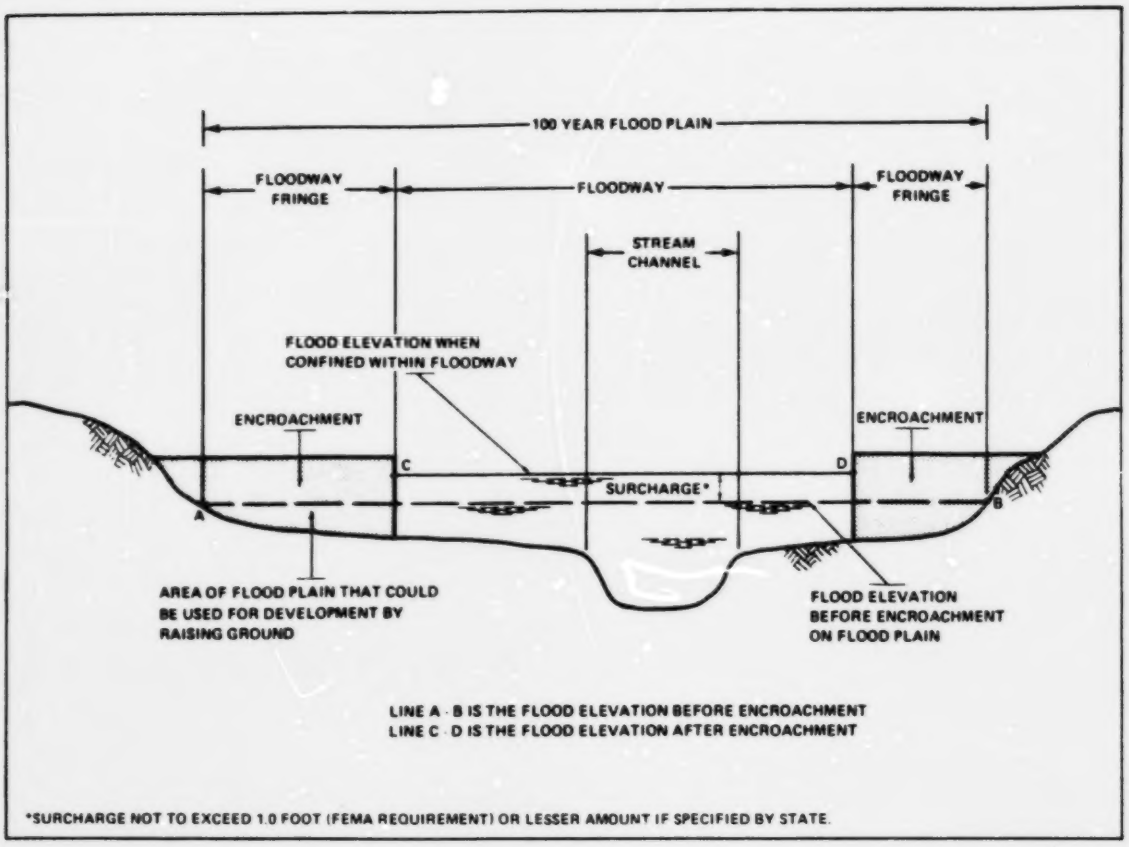
100 YEAR FLOOD PLAIN
FLOODWAY FRINGE
FLOODWAY
FLOODWAY FRINGE
STREAM CHANNEL
FLOOD ELEVATION WHEN CONFINED WITHIN FLOODWAY
ENCROACHMENT
ENCROACHMENT
C
D
SURCHARGE*
A
B
AREA OF FLOOD PLAIN THAT COULD BE USED FOR DEVELOPMENT BY RAISING GROUND
FLOOD ELEVATION BEFORE ENCROACHMENT ON FLOOD PLAIN
LINE A - B IS THE FLOOD ELEVATION BEFORE ENCROACHMENT
LINE C - D IS THE FLOOD ELEVATION AFTER ENCROACHMENT
*SURCHARGE NOT TO EXCEED 1.0 FOOT (FEMA REQUIREMENT) OR LESSER AMOUNT IF SPECIFIED BY STATE.

FLOODWAY SCHEMATIC Figure 2

5.1 Reach Determinations

Reaches are defined as sections of flood plain that have relatively the same flood hazard, based on the average weighted difference in water-surface elevations between the 10- and 100-year floods. This difference may not have a variation greater than that indicated in the following tabulation for more than 20 percent of the reach:

Average Difference Between 10- and 100-Year Floods	Variation
Less than 2 feet	0.5 foot
2 to 7 feet	1.0 foot
7.1 to 12 feet	2.0 feet
More than 12 feet	3.0 feet

The locations of the reaches determined for the flooding sources of the Township of Washington are shown on the Flood Profiles (Exhibit 1) and summarized in Table 3.

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FLOODING SOURCE	PANEL[1]	ELEVATION DIFFERENCE[2] BETWEEN 1.0% (100-YEAR) FLOOD AND			FHF	ZONE	BASE FLOOD ELEVATION[3] (NGVD)
		10% (10 YR.)	2% (50 YR.)	0.2% (500 YR.)			
West Branch Antietam Creek							
Reach 1	05	-0.8	-0.3	+0.7	010	A2	Varies
Reach 2	05	-1.6	-0.6	+1.5	015	A3	Varies
Reach 3	05	-2.9	-1.2	+3.6	030	A6	Varies
Reach 4	05	-1.3	-0.6	+2.0	015	A3	Varies
East Branch Antietam Creek							
Reach 1	05,10	-1.8	-0.6	+1.2	020	A4	Varies
Reach 2	05,10	-1.2	-0.4	+1.1	010	A2	Varies
Reach 3	10	-1.3	-0.4	+0.9	015	A3	Varies
Red Run							
Reach 1	05	-1.1	-0.5	+0.6	010	A2	Varies
Reach 2	05,10	-2.0	-1.1	+2.1	020	A4	Varies
Reach 3	10	-1.4	-0.6	+1.1	015	A3	Varies
Reach 4	10	-0.9	-0.4	+1.7	010	A2	Varies
Reach 5	10	-1.4	-0.7	+2.0	015	A3	Varies

[1]Flood Insurance Rate Map Panel
[2]Weighted Average
[3]Rounded to the nearest foot - see map

TABLE 3

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWNSHIP OF WASHINGTON, PA
(FRANKLIN CO.)

FLOOD INSURANCE ZONE DATA

WEST BRANCH ANTIETAM CREEK – EAST BRANCH ANTIETAM CREEK – RED RUN

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FLOODING SOURCE	PANEL[1]	ELEVATION DIFFERENCE[2] BETWEEN 1.0% (100-YEAR) FLOOD AND			FHF	ZONE	BASE FLOOD ELEVATION[3] (NGVD)
		10% (10 YR.)	2% (50 YR.)	0.2% (500 YR.)			
Falls Creek							
Reach 1	10	-1.4	-0.4	+1.3	015	A3	Varies
Reach 2	10	-0.6	-0.2	+0.6	005	A1	Varies

[1]Flood Insurance Rate Map Panel
[2]Weighted Average
[3]Rounded to the nearest foot - see map

TABLE 3

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWNSHIP OF WASHINGTON, PA
(FRANKLIN CO.)

FLOOD INSURANCE ZONE DATA

FALLS CREEK

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5.2 Flood Hazard Factors

The Flood Hazard Factor (FHF) is used to establish relationships between depth and frequency of flooding in any reach. This relationship is then used with depth-damage relationships for various classes of structures to establish actuarial insurance rate tables.

The FHF for a reach is the average weighted difference between the 10- and 100-year flood water-surface elevations rounded to the nearest one-half foot, multiplied by 10, and shown as a three-digit code. For example, if the difference between water-surface elevations of the 10- and 100-year floods is 0.7 foot, the FHF is 005; if the difference is 1.4 feet, the FHF is 015; if the difference is 5.0 feet, the FHF is 050. When the difference between the 10- and 100-year flood water-surface elevations is greater than 10.0 feet, it is rounded to the nearest whole foot.

5.3 Flood Insurance Zones

Flood insurance zones and zone numbers are assigned based on the type of flood hazard and the FHF, respectively. A unique zone number is associated with each possible FHF, and varies from 1 for a FHF of 005 to a maximum of 30 for a FHF of 200 or greater.

Zone A:	Special Flood Hazard Areas inundated by the 100-year flood, determined by approximate methods; no base flood elevations shown or FHFs determined.
Zones A1, A2, A3, A4, and A6:	Special Flood Hazard Areas inundated by the 100-year flood; with base flood elevations shown, and zones subdivided according to FHFs.
Zone B:	Areas between the Special Flood Hazard Areas and the limits of the 500-year flood; areas that are protected from the 100- or 500-year floods by dike, levee, or other water control structure; areas subject to certain types of 100-year shallow flooding where depths are less than 1.0 foot; and areas subject to 100-year flooding from sources with drainage areas less than 1 square mile. Zone B is not subdivided.
Zone C:	Areas of minimal flooding; not subdivided.

Flood elevation differences, FHFs, flood insurance zones, and base flood elevations for the flooding sources studied in detail in the community are shown in Table 3.

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5.4 Flood Insurance Rate Map Description

The Flood Insurance Rate Map for the Township of Washington is, for insurance purposes, the principal result of the Flood Insurance Study. This map contains the official delineation of flood insurance zones and base flood elevations. Base flood elevation lines show the locations of the expected whole-foot water-surface elevation of the base (100-year) flood. The base flood elevations and zone numbers are used by insurance agents, in conjunction with structure elevations and characteristics, to assign actuarial insurance rates to structures and contents insured under the National Flood Insurance Program.

6.0 OTHER STUDIES

Flood Insurance Studies for Washington County, Maryland, and the Township of Antrim, Pennsylvania, have been completed (References 4 and 13). The results of this study are in exact agreement with the results of those studies.

The Flood Insurance Study for the Borough of Waynesboro is currently being prepared (Reference 14). The results of that study will be in exact agreement with the results of this study.

7.0 LOCATION OF DATA

Information concerning the pertinent data used in preparation of this study can be obtained by contacting the Natural and Technological Hazards Division, Federal Emergency Management Agency, Regional Director, Region III Office, Liberty Square Building (Second Floor), 105 South Seventh Street, Philadelphia, Pennsylvania 19106.

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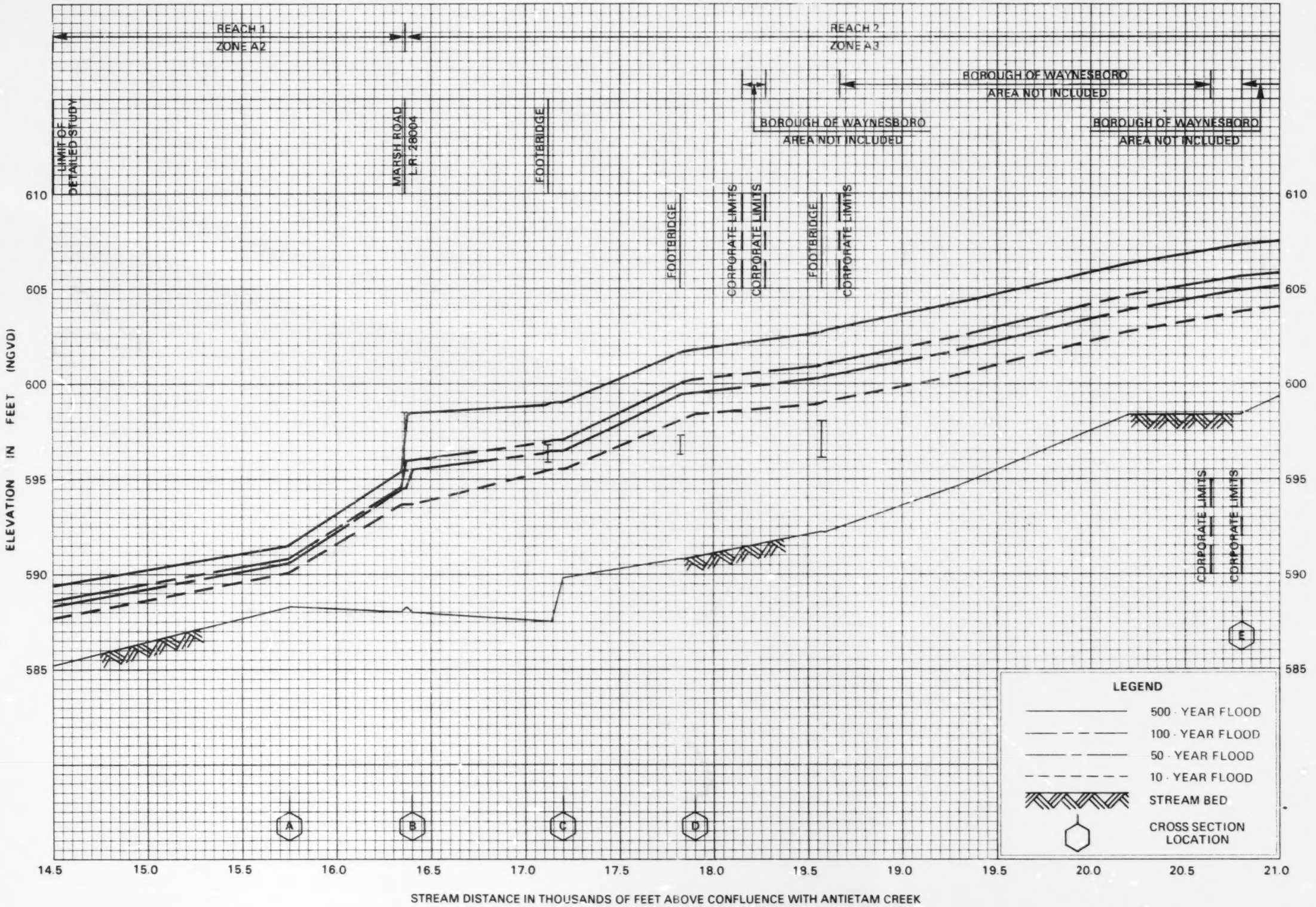

FLOOD PROFILES

WEST BRANCH ANTIETAM CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWNSHIP OF WASHINGTON, PA
(FRANKLIN CO.)

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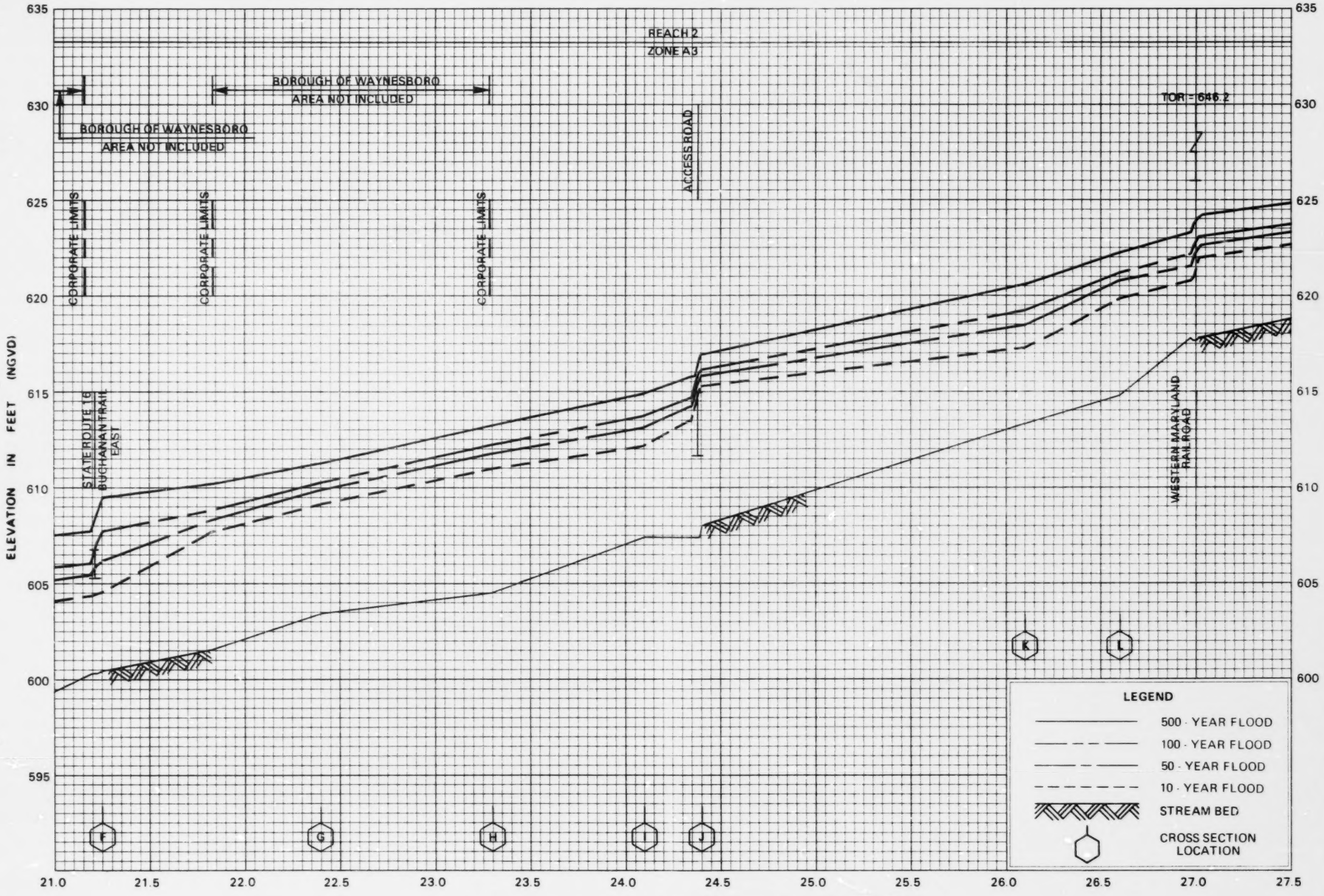

FLOOD PROFILES

WEST BRANCH ANTIETAM CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWNSHIP OF WASHINGTON, PA

(FRANKLIN CO.)

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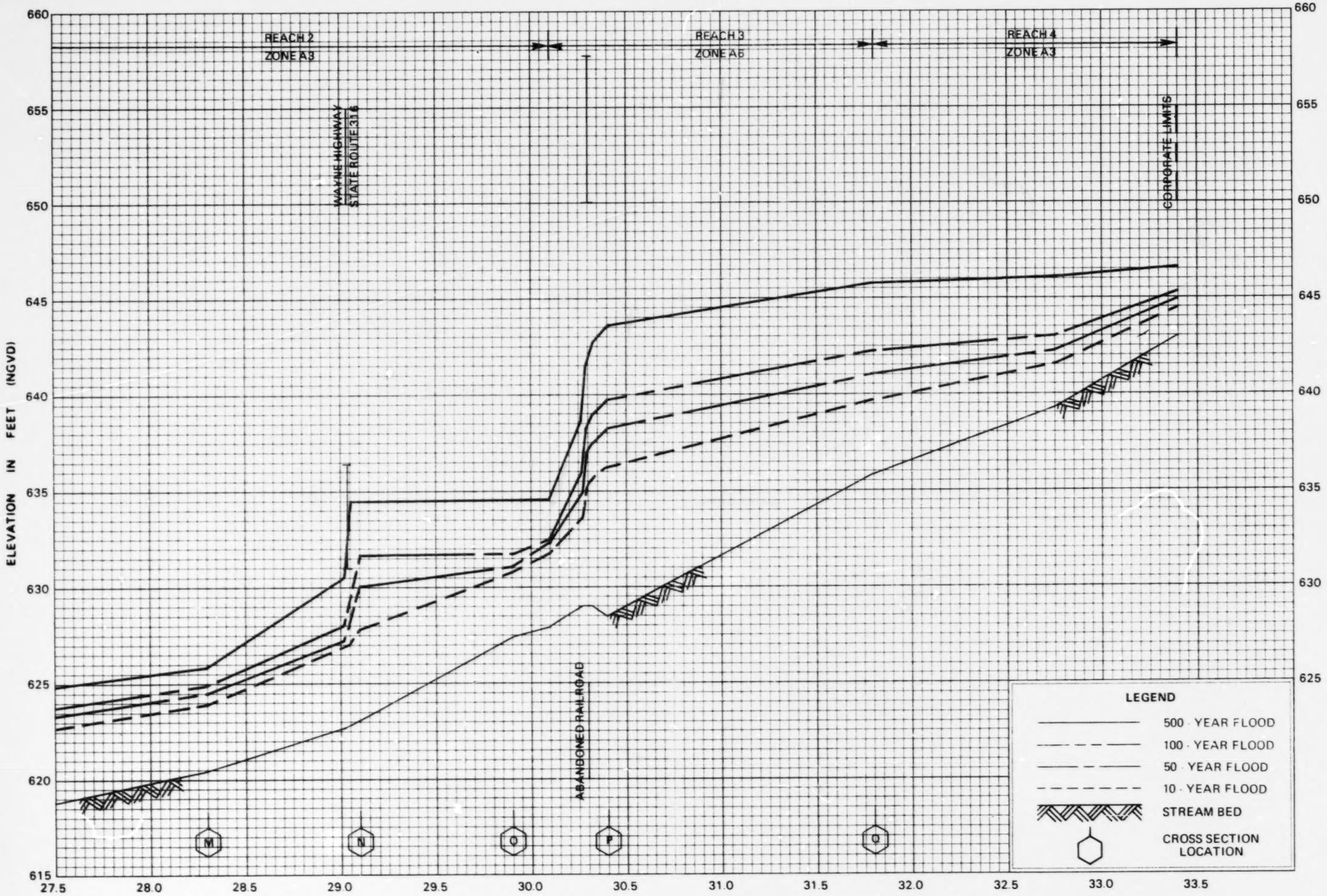

FLOOD PROFILES

WEST BRANCH ANTIETAM CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWNSHIP OF WASHINGTON, PA

(FRANKLIN CO.)

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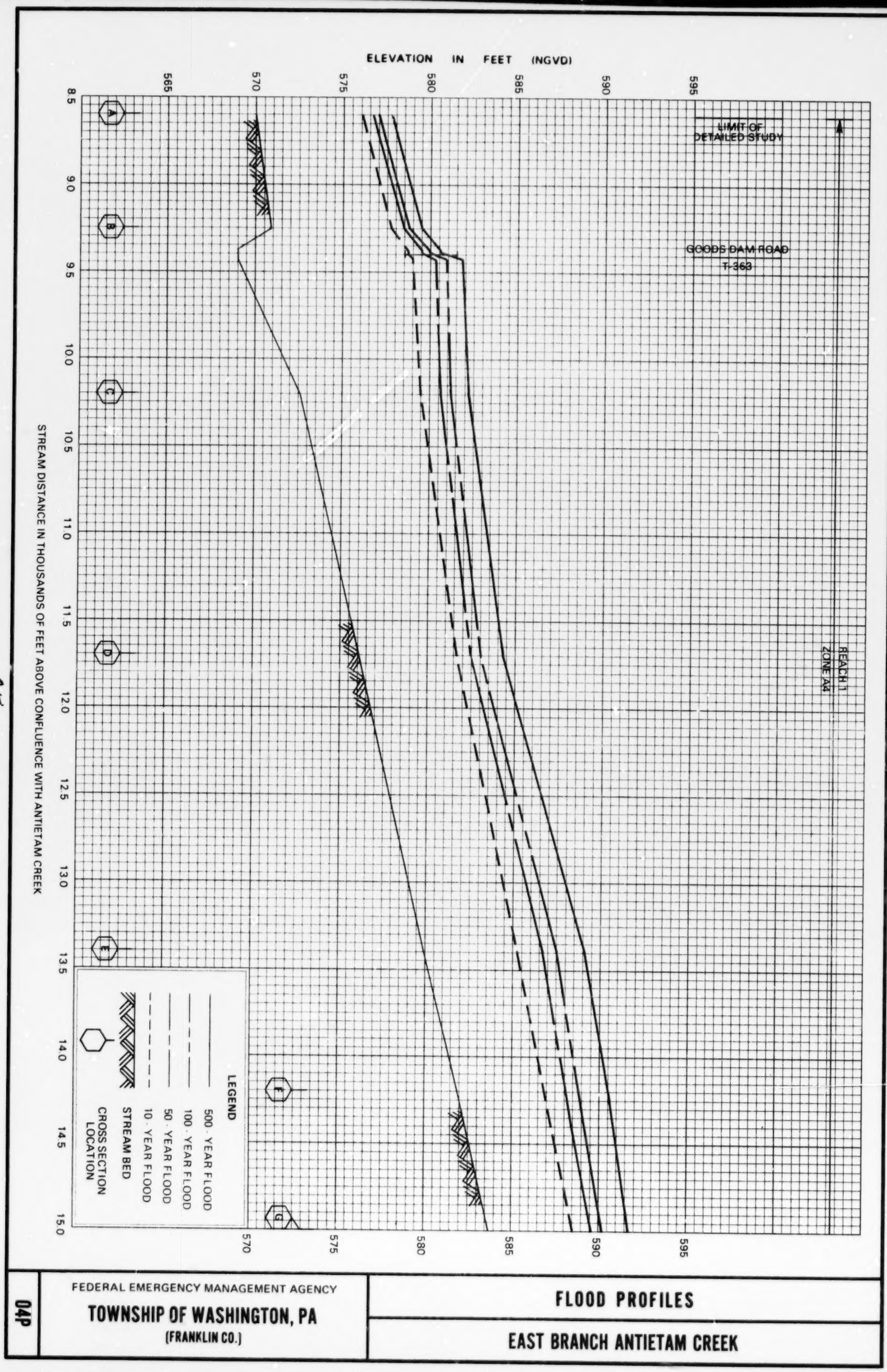

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FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWNSHIP OF WASHINGTON, PA

(FRANKLIN CO.)

FLOOD PROFILES

EAST BRANCH ANTIETAM CREEK

25

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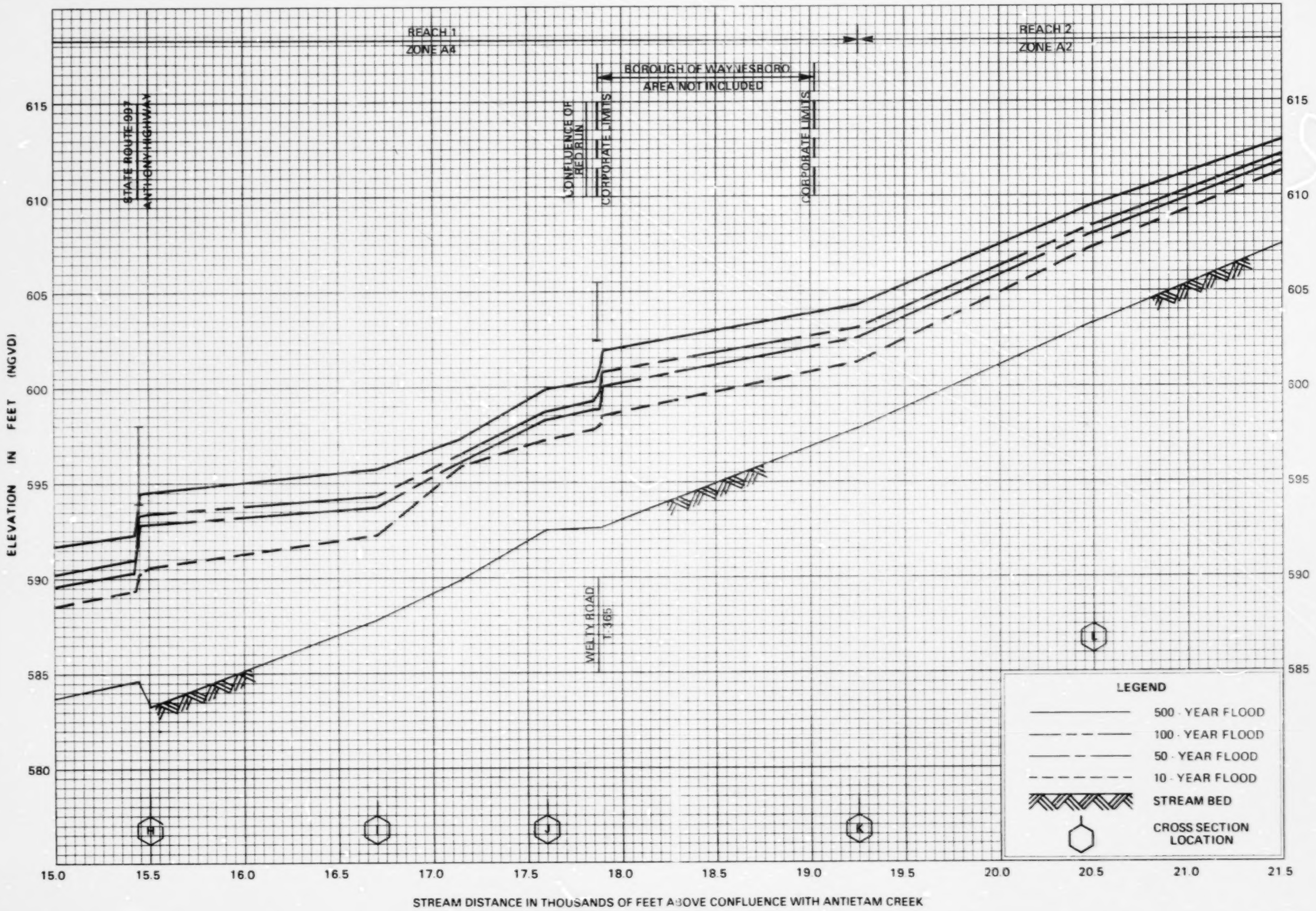

FLOOD PROFILES

EAST BRANCH ANTIETAM CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWNSHIP OF WASHINGTON, PA

(FRANKLIN CO.)

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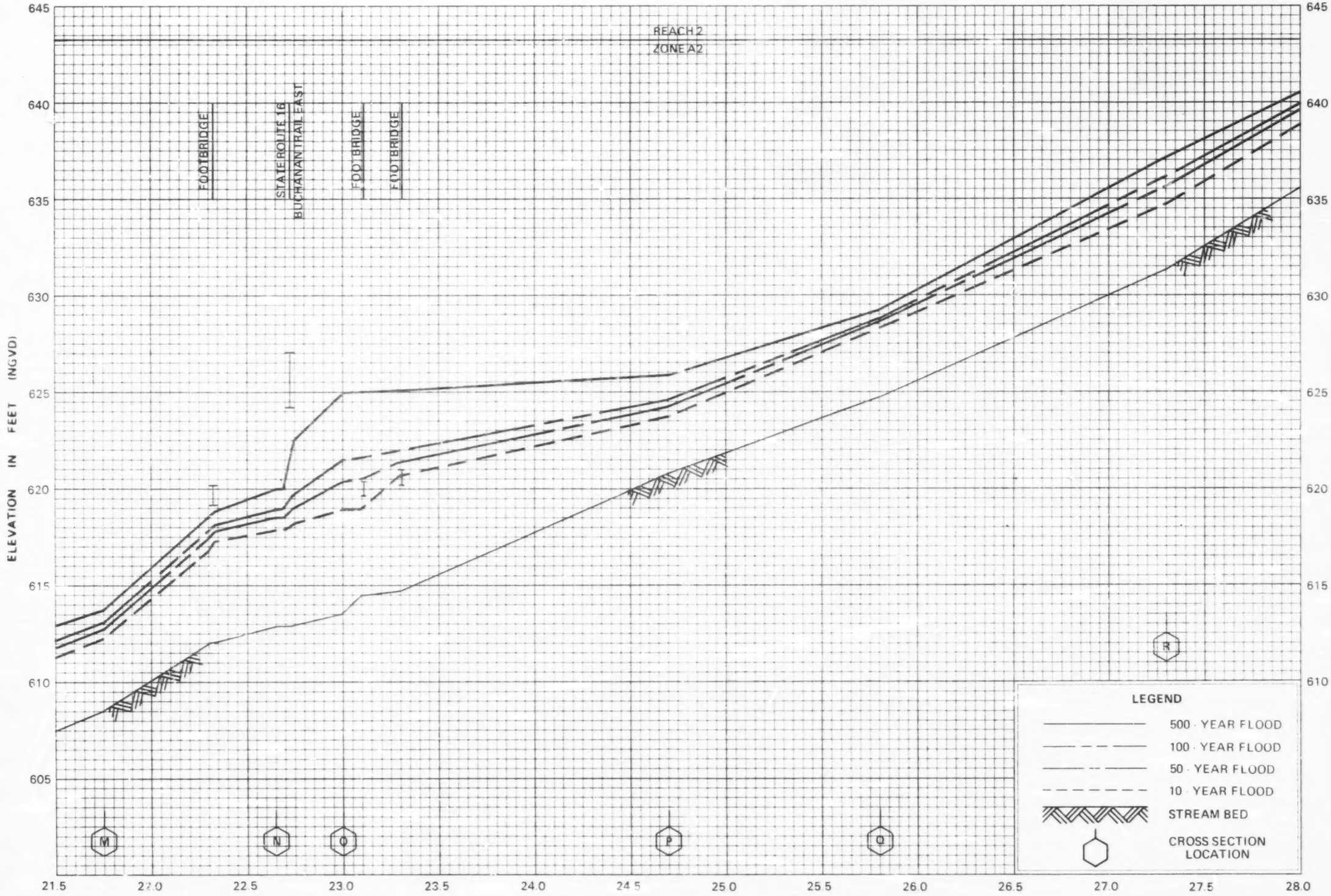

FLOOD PROFILES

EAST BRANCH ANTIETAM CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWNSHIP OF WASHINGTON, PA

(FRANKLIN CO.)

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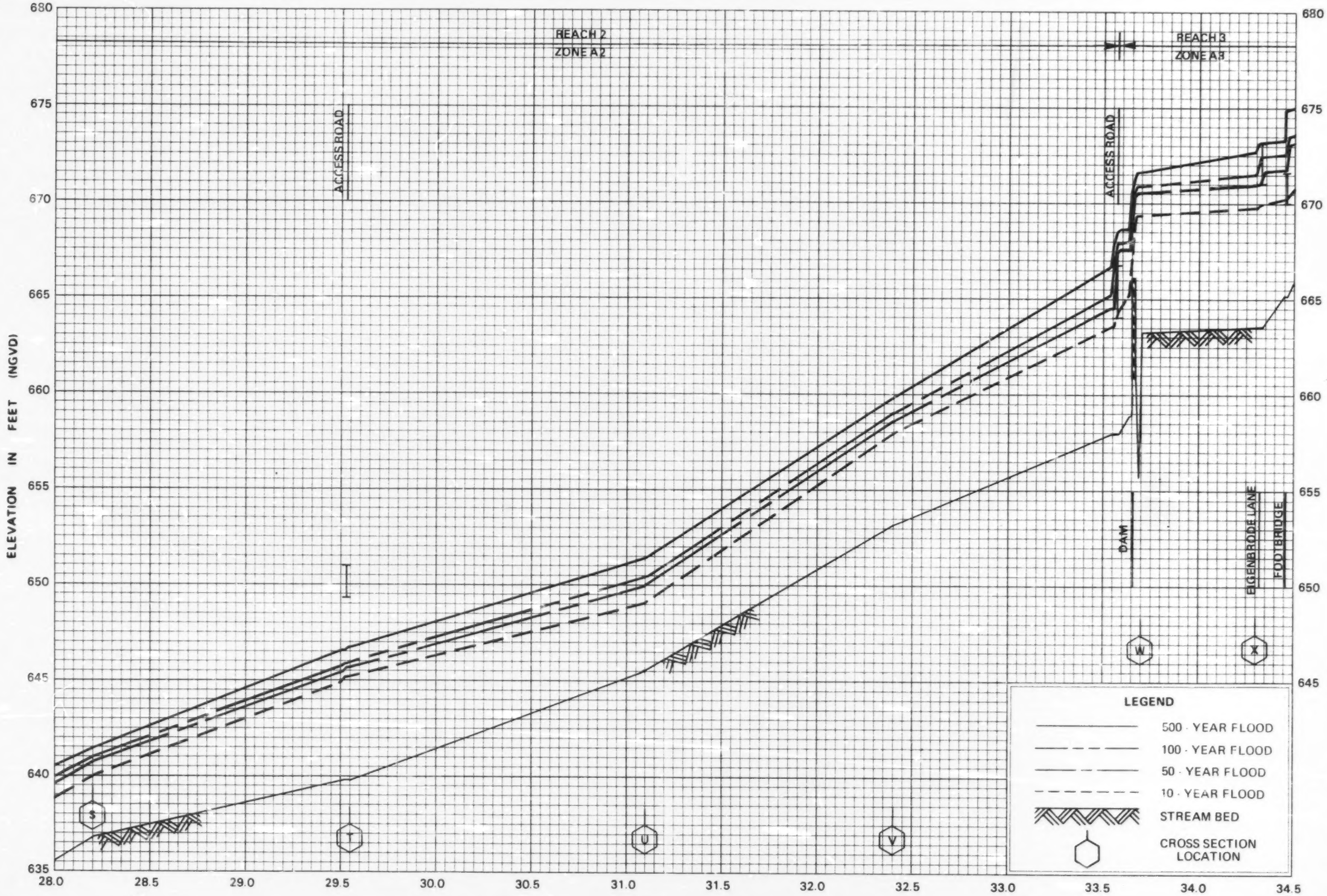

FLOOD PROFILES

EAST BRANCH ANTIETAM CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWNSHIP OF WASHINGTON, PA

(FRANKLIN CO.)

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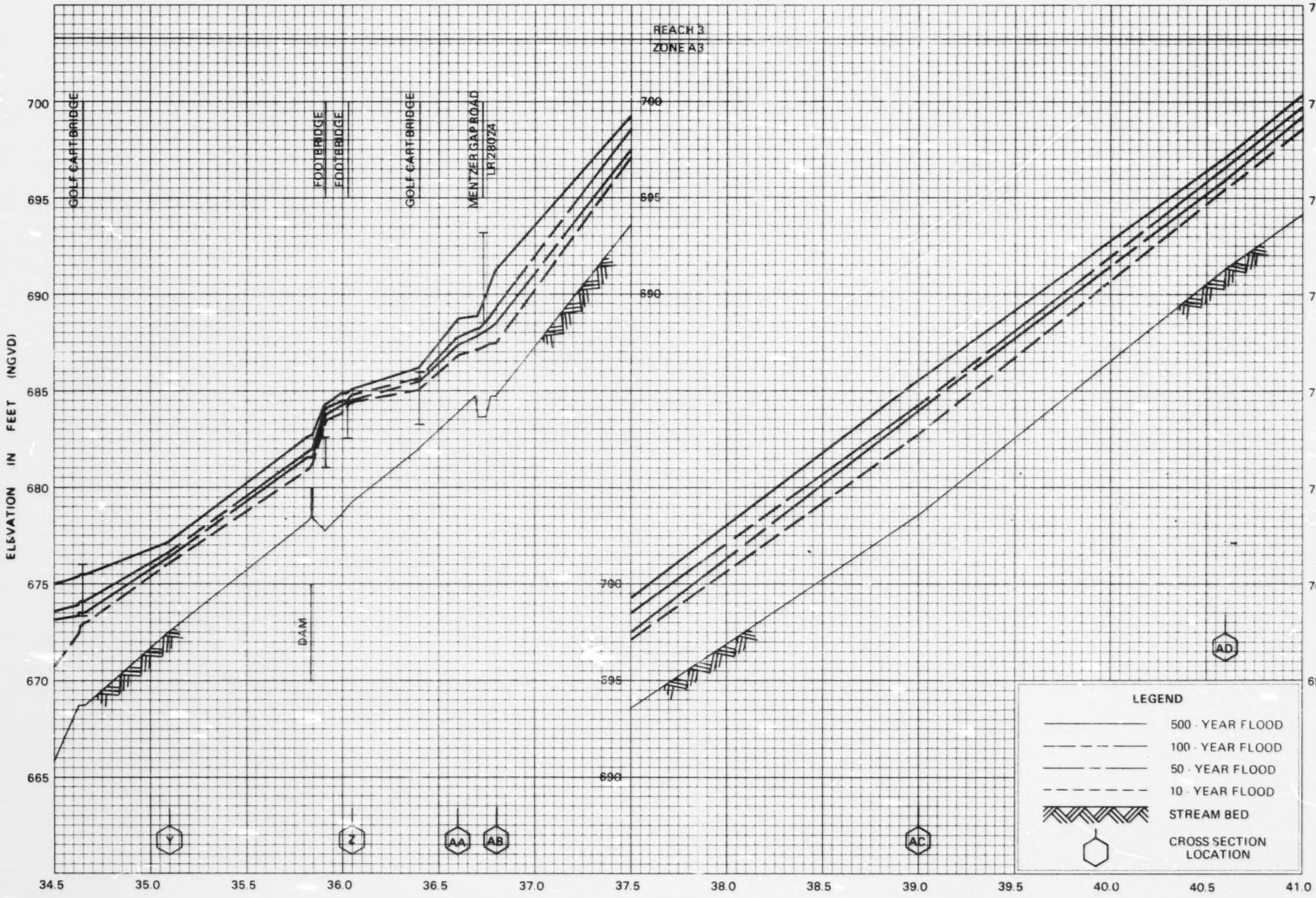

STREAM DISTANCE IN THOUSANDS OF FEET ABOVE CONFLUENCE WITH ANTIETAM CREEK

FLOOD PROFILES

EAST BRANCH ANTIETAM CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWNSHIP OF WASHINGTON, PA

(FRANKLIN CO.)

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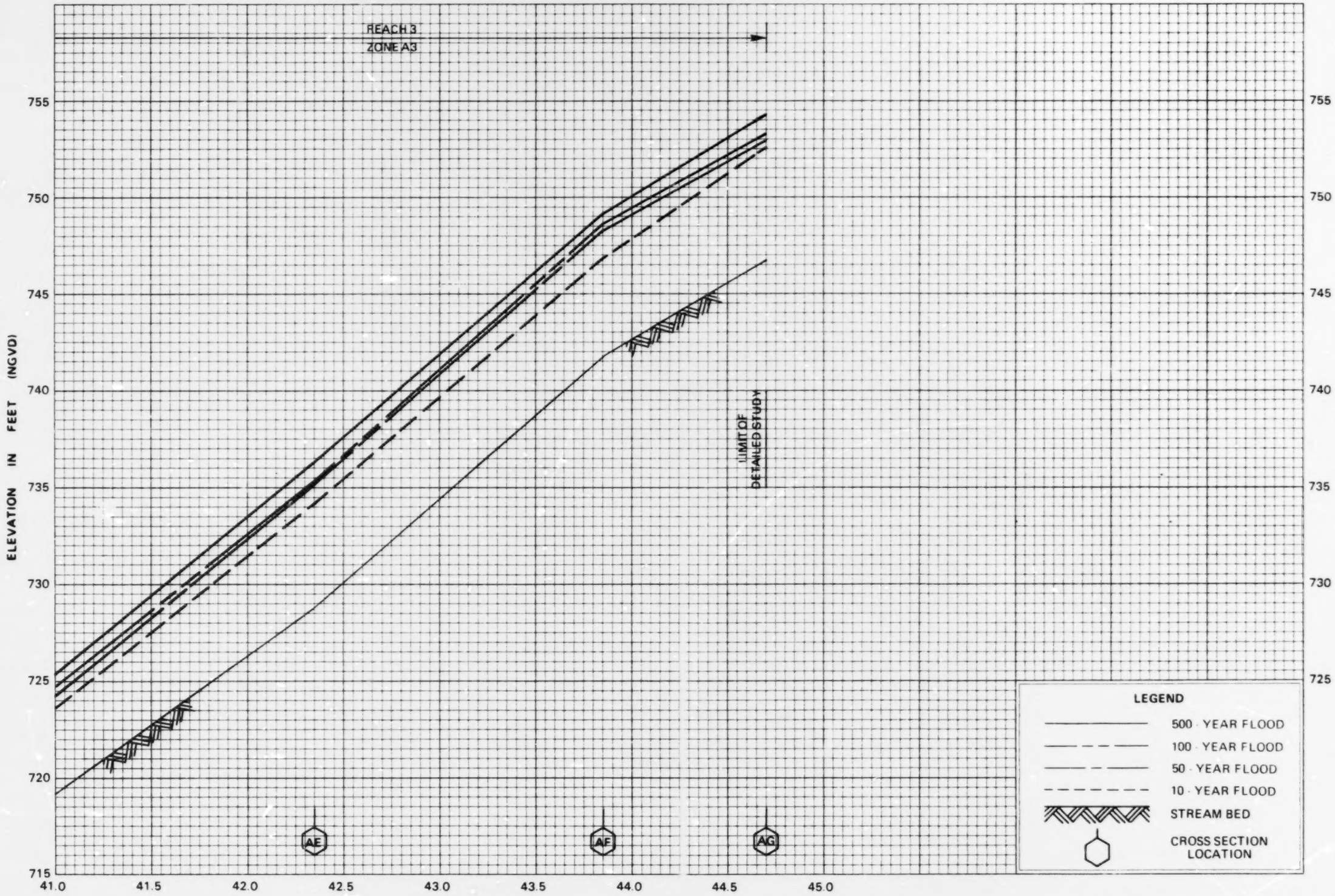

FLOOD PROFILES

EAST BRANCH ANTIETAM CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWNSHIP OF WASHINGTON, PA

(FRANKLIN CO.)

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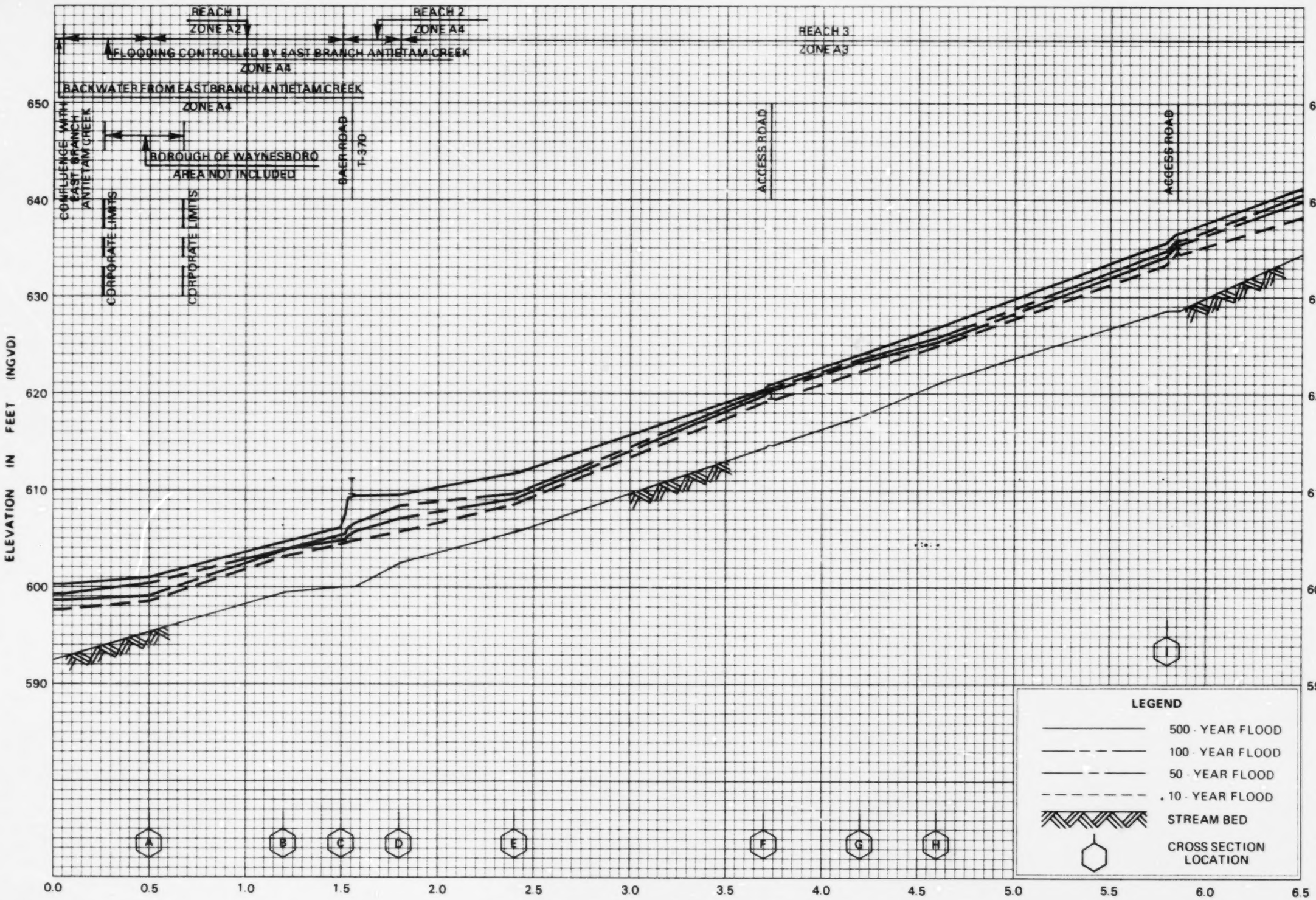

FLOOD PROFILES

RED RUN

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWNSHIP OF WASHINGTON, PA

(FRANKLIN CO.)

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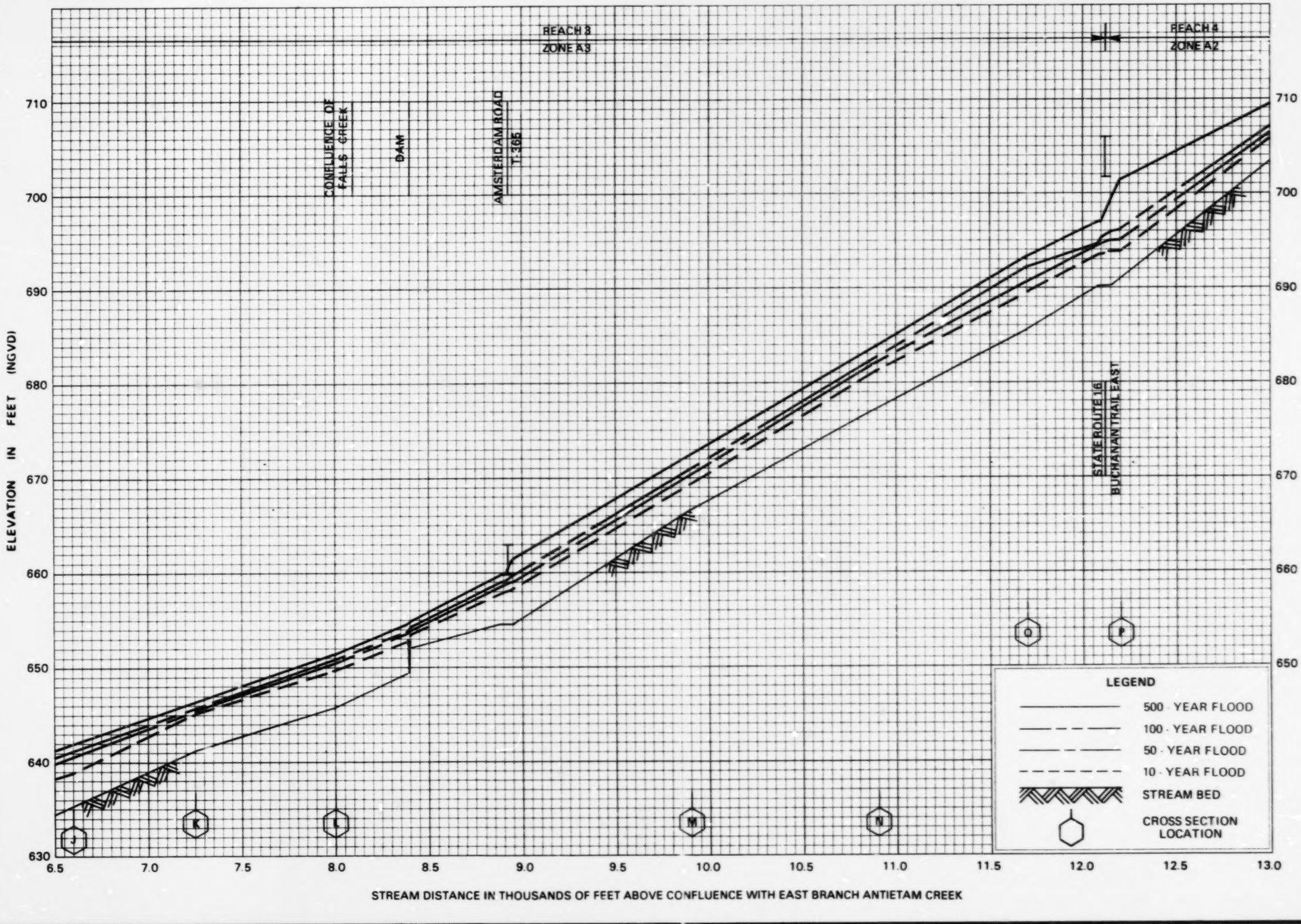

FLOOD PROFILES

RED RUN

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWNSHIP OF WASHINGTON, PA

(FRANKLIN CO.)

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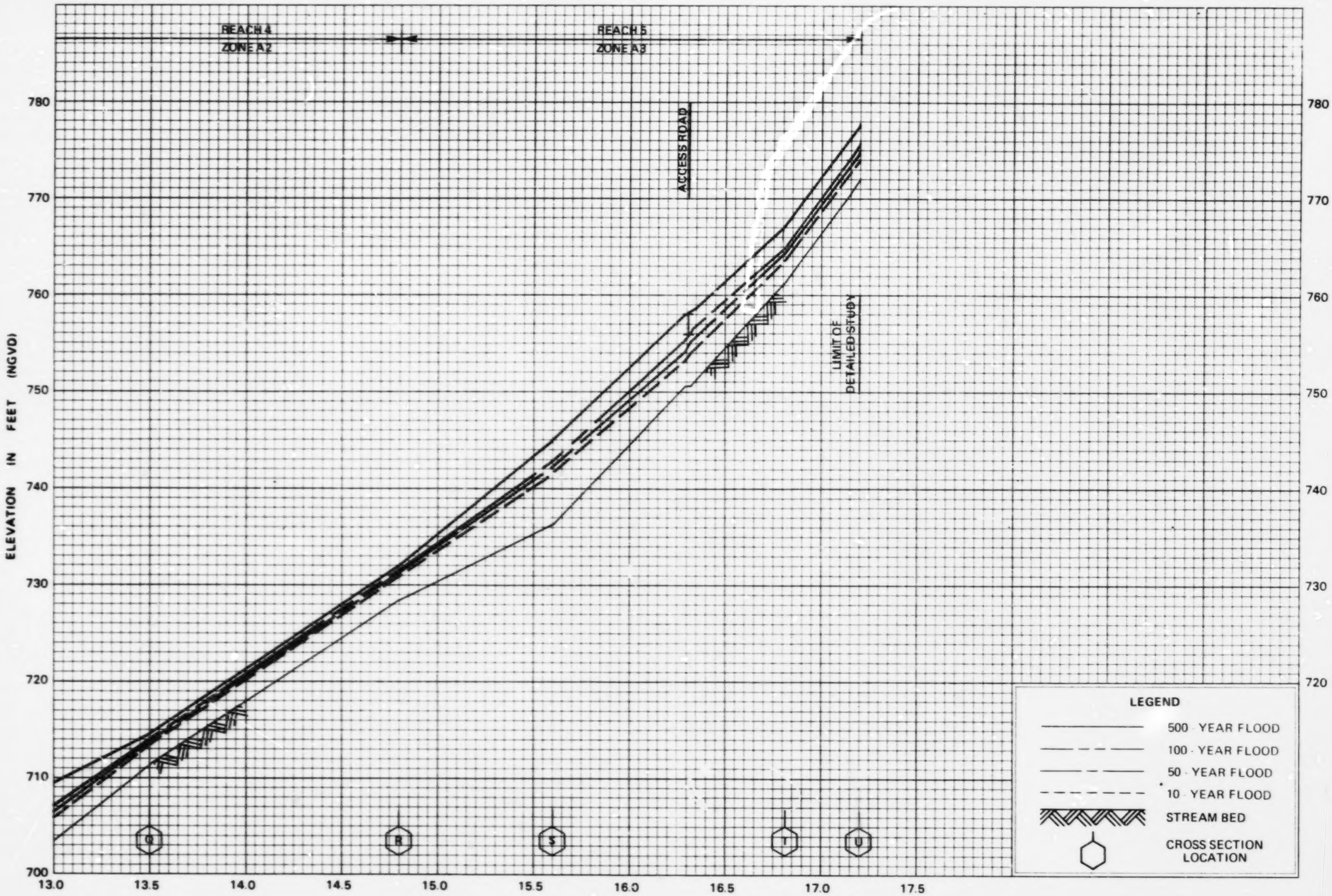

FLOOD PROFILES

RED RUN

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWNSHIP OF WASHINGTON, PA

(FRANKLIN CO.)

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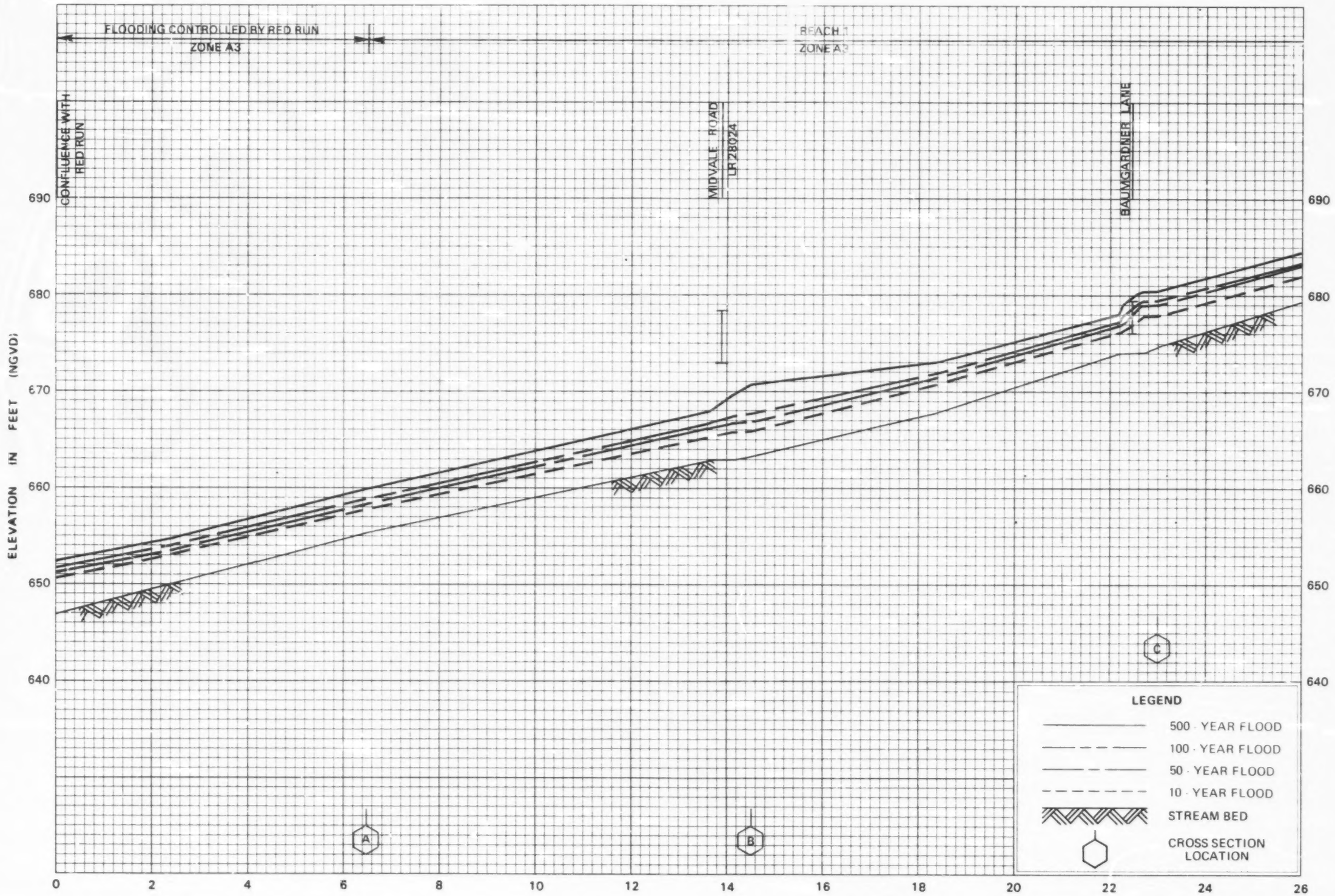

FLOOD PROFILES

FALLS CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWNSHIP OF WASHINGTON, PA

(FRANKLIN CO.)

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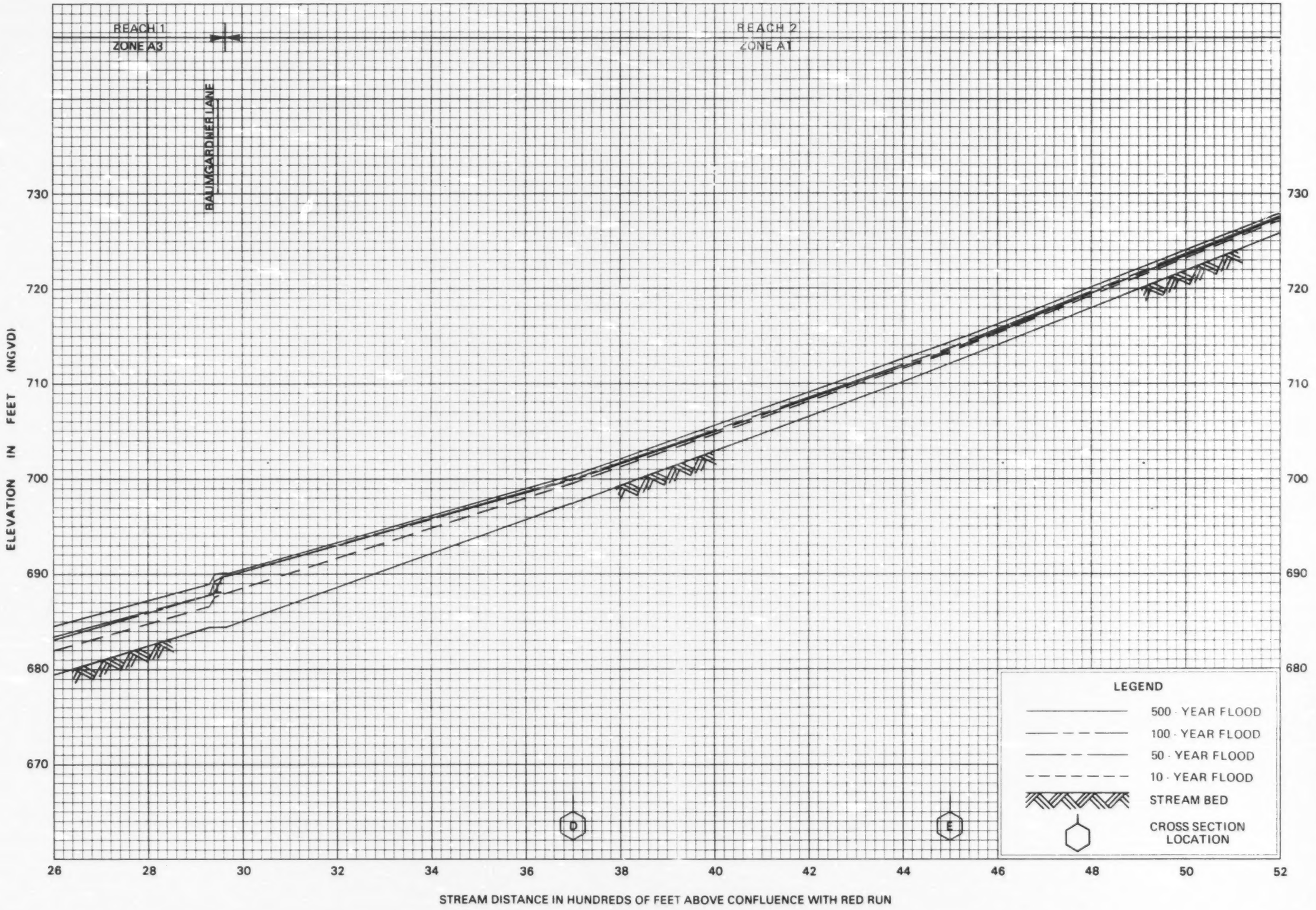

FLOOD PROFILES

FALLS CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWNSHIP OF WASHINGTON, PA
(FRANKLIN CO.)

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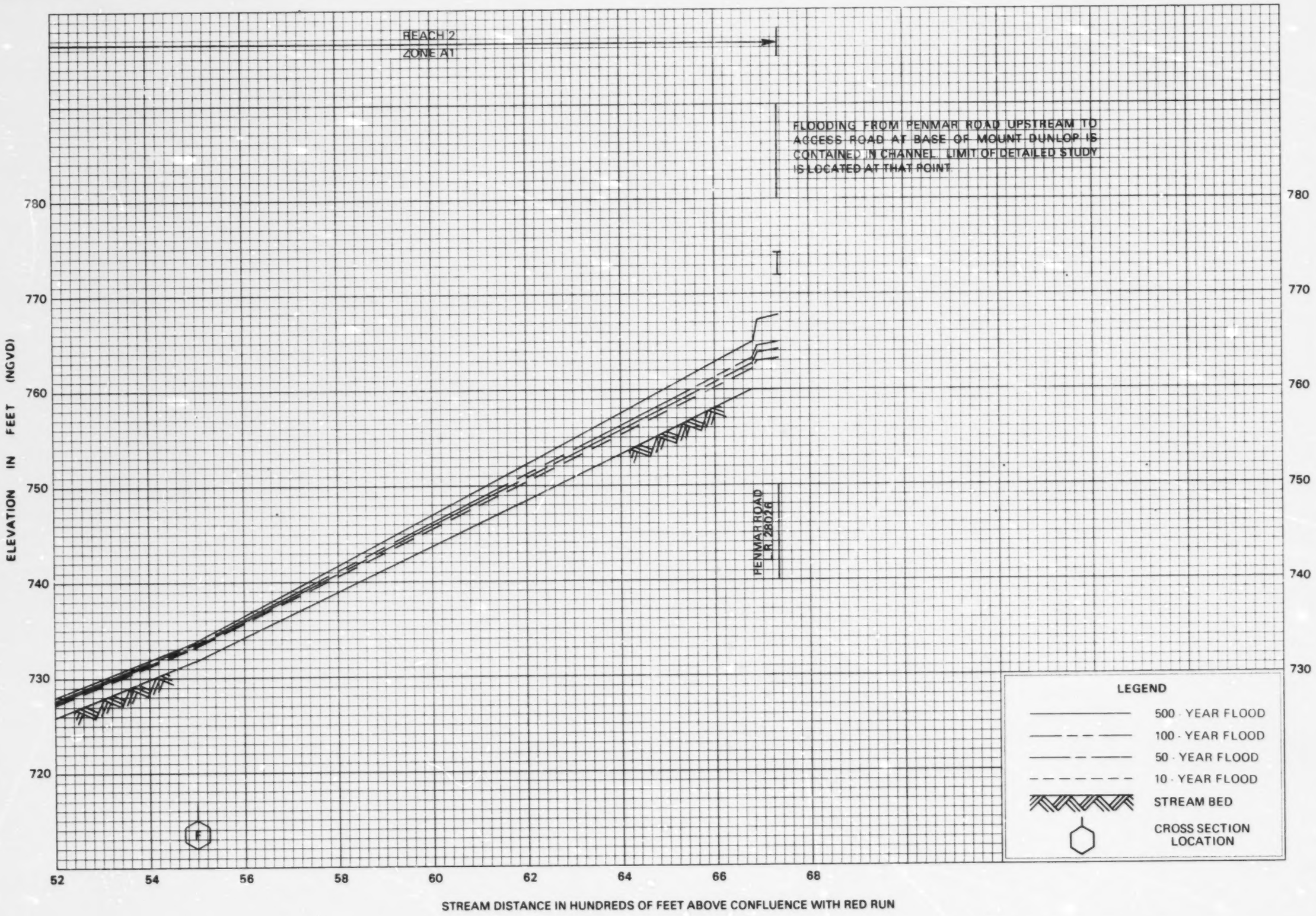

FLOOD PROFILES

FALLS CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWNSHIP OF WASHINGTON, PA
(FRANKLIN CO.)

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